



Technology Evaluation for Environmental Risk Mitigation Principal Center

Membrane Removal of VOCs from Entrained Air Streams

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Background

Federal and local regulations continue to reduce the allowable level of volatile organic compounds (VOCs) that can be emitted into the atmosphere. This can affect whether or not new or modified operations receive permits. It also impacts NASA remediation activities that generate VOCs as pollutants are removed from soils and groundwater.

Technologies currently used within process lines and remediation sites to capture, destroy or otherwise reduce VOC stack emissions include catalytic oxidizers, thermal regenerative oxidizers, carbon adsorption / solvent recovery, hybrid concentrators and gas turbine oxidizers to name a few. Recently, developments have been made in the world of semi-permeable membranes that can allow for the separation and capture of VOCs from entrained air-streams.

Hollow fiber-based vapor permeation process employs a lumen-side feed flow essentially at atmospheric pressure and vacuum on the shell side. The excellent separation performance obtained with small membrane modules has inspired the exploration of the performances of larger commercial-size hollow fiber cartridges and multiple cartridge-containing modules for treating real-life VOC-containing gas streams.

Results from two pilot-scale studies showed that more than 95% of the VOC present in the feed was successfully removed in each process. The pilot studies focused on the emission from a batch reactor in a pharmaceutical plant (emitting 2.5% toluene, 4% ethyl acetate and 14% methanol at a rate of 10-80 l/m) and the air emissions from a paint booth (emitting very low levels of VOCs in the 5-100 ppmv range). This novel membrane technology is capable of removing up to 98% of VOCs from nearly any entrained air stream. VOCs can then be captured and condensed into a liquid that may be recycled or reused.

Objective

Demonstrate and validate the novel membrane technology at two to three NASA Centers and on the widest variety of air streams possible. Determine efficiency, return on investment of potential implementation, and the best potential processes for implementation.

Period of Performance

- March 2006 to May 2009.

Stakeholders

The initial test site for this scaled-up test was a jet-fuel remediation site at Wallops Flight Facility. Future test sites continue to be identified for further testing both in the United States of America and Portugal.

Benefits

- Dramatic reduction of VOCs to the atmosphere (>90%)
- Reduction of the public's exposure to hazardous materials
- Cost savings over thermal oxidation and conventional membrane technologies
- Decreased carbon dioxide footprint over VOC destruction technologies that utilize fossil fuels
- Small footprint of technology over other methods to capture / destroy VOCs. Compact devices allow for point of use application
- Moderate capital cost, low operational cost
- Reduction of environmental footprint, moving toward sustainability.

Document Status

- Draft field test plan – Complete. – February 2008.
- Draft final report – Complete – November 2008.

Recent Progress

- Coordinating with Michoud Assembly Facility and Fairchild Air Force Base as well as several private facilities to identify and confirm next test location.
- Future testing will require more funding, and will involve simulating air emissions of interest at Applied Membrane Technology's (AMT) Facility in Minnesota.

Milestones

- Completed the fabrication of membrane fibers, January 2007.
- Completed laboratory testing at New Jersey Institute of Technology and simulations of Wallops Flight Facility, May 2007.
- Completed the fabrication of modules to house fibers, May 2007.
- Completed face-to-face and 85% design review of test platform, June 2007.
- Completed Initial assembly of platform, July 2007.
- Completed construction of platform dry-run testing, July 2007.
- Shipped equipment to Wallops Flight Facility, August 2007.
- Completed initial testing at Wallops Flight Facility, October 2007.
- Finished Secondary and Final testing at Wallops Flight Facility, March 2008.
- All equipment was shipped to AMT – October 2008.
- Completed draft final report – November 2008.

Near-Term Goals

- Develop plans needed for international demonstration.
- Determine funding need and source for international demonstration.
- Continue to identify potential NASA Stakeholders and provide testing at AMT to satisfy needs.

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